

observers in connection with the work in question, and the measures now published not only confirm this favourable opinion of the instrument, but bear inherent testimony to the care and patience expended on the observations, and will doubtless be received as an important and valuable contribution to double-star astronomy, and especially by those who are occupied with similar observations, or the investigation of the orbits of the binary systems. Amongst the more interesting of the revolving stars, the Catalogue has measures of η Cassiopeæ, 36 Andromedæ, α Geminorum, ζ Cancri, ω Leonis (which difficult object was just divided at the end of March 1873), ξ Ursæ Majoris, γ Virginis, ξ Bootis, η Coronæ, Σ 1938, ζ Herculis, 70 Ophiuchi, Σ 3062, &c. The interesting, though difficult binary Σ 518 (Eridani), is probably within the power of such an instrument, but does not appear in the Catalogue; it may be suggested that it is not too late to examine this object in the present season, the actual angle may probably be found very considerably in advance of that obtained by Prof. Winnecke in 1864, and a first approximation to the form of the orbit may soon be practicable.

JUPITER'S SATELLITES.—If we take a mean of the measures of the diameters of the satellites by Struve at Dorpat, and by Engelmann at Leipsic, we shall have for apparent diameters at the mean distance of the primary:—

I. ... $1''\cdot048$ II. ... $0''\cdot911$... III. $1''\cdot513$... IV. $1''\cdot278$
and with a solar parallax of $8''\cdot875$, the true diameters in English miles will be:—

I. ... 2,435 ... II. ... 2,115 ... III. 3,515 ... IV. 2,970
The angular diameters at the centre of Jupiter, are:—

I. ... $31'\cdot4$ II. ... $17'\cdot1$ III. ... $17'\cdot8$ IV. ... $8'\cdot6$
and the mean distances from the centre of Jupiter:—

I. ...	266,700 miles
II. ...	424,300 "
III. ...	676,800 "
IV. ...	1,190,400 "

The diameter of the planet's equator is assumed to be 88,200 miles, as lately given in this column.

THE DRAINAGE OF THE ZUYDER ZEE.

THE Dutch are a people who in many respects command the respect of the world. Their little country possesses comparatively few natural resources, and yet they have made so much of it, and they have been compelled to cultivate the virtues of frugality and industry to such an extent, that the people as a whole are probably better off than those of any other country in the world. Small as the country is, it is only by the exercise of great skill and constant watchfulness that they are able to prevent its being overwhelmed by the German Ocean. In this unfortunately they have not always been successful. Over and over again has the sea burst in upon them, laying waste their dearly-loved country, and sweeping away thousands of the inhabitants. It has only been after many severe lessons that they have learned how to keep the invader back. And within recent years they themselves have taken the offensive, and determined to drive out old Neptune from lands which he has possessed for centuries. Even in the seventeenth and eighteenth centuries they succeeded in draining many small areas of land, and during the present century many marshes and lakes have been brought under cultivation, including Lake Haarlem, upwards of 40,000 acres in extent. In this way about 350 square miles of land, mostly devoted to pasture, have been reclaimed, and that entirely by means of windmills.

Now, however, that the applications of steam-power have reached such perfection, this enterprising people have determined upon an enterprise much more gigantic than

any they have hitherto attempted,—nothing less than the drainage of the Zuyder Zee. Until the end of the thirteenth century the area now occupied by that arm of the ocean seems to have been mostly dry land, with a lake in the centre, which by means of a river drained into the German Ocean. At the time mentioned, however, in 1282 according to some authorities, the sea broke through what is now the Strait of Helder, and converted the dry land into a gulf.

For many years the drainage of the Zuyder Zee has occupied the attention of the Dutch Government and of engineers, but it is only since the improvements in the application of steam that the idea has been seriously entertained. At last a scheme has been adopted, after many years' careful research and consideration, for the details of which we are indebted to the French journal *L'Explorateur*.

As early as 1865 a Dutch Credit Foncier Association took up the scheme at the suggestion of Mr. Rochussen, an eminent statesman, and employed two engineers, M. Beijerinck, who drained the Haarlem Lake, and M. Stieltjes. These reported on the practicability of draining the southern, the shallowest and most fertile, half of the inland sea. Soundings were made, and numerous specimens of the bottom brought up, and in short a thorough investigation made from a geological and agronomic point of view. The result of these investigations was most favourable, and the specimens submitted to the analysis of a distinguished agricultural chemist, M. van Bemmelen, having been found to consist of alluvial clay or loam of the first quality and of great depth, over an extent of four-fifths of the bottom of the sea, the Society entered into negotiations with the Government. A Government Commission was appointed to consider the whole question from an economic and scientific point of view, and after an investigation lasting about two years, gave in their report in April, 1868. This report was in favour of granting a concession to the Credit Foncier, whenever that company could present a definite plan that would obviate all existing objections. The Society, after further consideration, requested the Government to delegate a commission of specialists to report further on the scheme, taking into consideration all the interests concerned, and to decide upon the plan best adapted to carry the scheme into execution. After three years thorough consideration the Commission gave in a voluminous report in April 1873, which declared that the project from an engineering point of view was practicable; that the clearing of the new lands would be a difficult and very expensive enterprise, but that the experience acquired and the progress of science would furnish the means of overcoming these difficulties, and of making the enterprise a benefit to the country.

The drainage will be effected in that part of the gulf lying between the provinces of Guelderland, Utrecht, and North Holland, over an extent of 195,300 hectares (about 740 square miles, nearly equal to the area of Surrey, and about 100 miles larger than the Dutch province of Zeeland), by means of a principal dike or embankment, of 40 kilometres in length, 50 metres broad at the base, and raised 5 metres above the ordinary tides, to be constructed from the left bank of the mouth of the Yssel to the island of Urk, and from hence to the town of Enkhuysen in the province of North Holland. The inclosed area will be divided into squares, and numerous pumping steam-engines will then be set to work, having a collective force of 9,400-horse power. The Commission estimates that the work will be entirely accomplished in sixteen years, and that it will cost a sum of 10,000,000*l.* not including the interest of the capital employed; or 1,600,000*l.* for preparatory works, provisional circular canals, &c., about 2,760,000*l.* for the construction of the dike, and the rest for the purchase of engines, the drainage proper, and the construction of reservoirs, internal canals, roads, railway

lines, and works preparatory to bringing the new lands under culture.

The interest on the above sum will raise it to 13,400,000*l.*, but one-fourth of this will be granted as a subsidy by government, which will be amply compensated by the comparatively enormous addition to its small territory.

Of the 473,000 acres to be drained, four-fifths, as we have said, are of great value, composed as they are of a bed of more than a metre thick of the most fertile mud deposited for centuries by the Yssel and other rivers of which the Zuyder Zee is the receptacle. Only one-fifth consists of land of less value and of sands which will be useful in constructing the base of the dike, or to establish large reservoirs, indispensable in all drainage work, for the reception of the waters until they can be conveyed to the sea. Deduction being made for the land absorbed by these works, by canals, dikes, roads, &c. &c., there will remain upwards of 400,000 acres suitable for culture, and the selling value of which ought considerably to exceed the expenses of the enterprise. Every one must wish that this bold and really beneficent scheme may be carried out with complete success.

THE BIRDS OF NORTH-EASTERN AFRICA¹

BARON THEODOR VON HEUGLIN is well known as one of the most active and successful of the travellers and naturalists of Germany—one who may fairly rank with the Wallaces and Bates of our own country—as regards the extent of his researches. No man living has devoted more time and toil to the investigation of the Fauna of North-eastern Africa, and as regards the classes of birds and mammals, no man living has a better acquaintance with them. Twelve years passed on the coasts and islands of the Red Sea, in the marshes and jungles of the White Nile, and in the Highlands of Abyssinia, during which time constant attention was devoted to the observation and collection of animals have given Herr von Heuglin unrivalled opportunities for amassing this knowledge, to which his skill as an artist has contributed additional facilities. Soon after returning from his last journey in 1865, Herr von Heuglin planned a general work on the Ornithology of North-eastern Africa to embrace all the notes and observations collected during his different excursions, together with the information acquired by the study of specimens from these countries already existing in the continental museums. In 1869, the first part of the present work was issued, but its large extent hindered its progress, and the author was called away to join the German Expeditions to Nova Zembla and the extreme north, to which he was attached as naturalist. It was not, therefore, until the close of last year, or, we believe we may say until the beginning of the present year, that the concluding part of the Ornithology of North-eastern Africa was issued from the press. Completed, it now forms four volumes, illustrated by fifty-one coloured plates and a map of the region of which it treats, and is by far the most perfect work on the subject hitherto published. Prior to the completion of the present work Rüppell's Atlas, and other publications were, so far as regards Nubia and Abyssinia, the only works of reference, whilst of the district of the White Nile so fully explored by Von Heuglin, very little was known except from fragmentary notices. In the present extended work the ornithology of the whole of these countries, together with that of Egypt, the Red Sea, and Northern Somali-land, are treated of together. The sum of species of birds is thus raised to a high figure, no less than 948, of which upwards of 200 are entirely confined to North-eastern Africa. European species are likewise numerous in these countries,

Northern Africa being, as is well known, the favoured haunt of our summer migrants during the winter season. Upwards of 300 European birds thus come to be included in Herr von Heuglin's list. The plan of our author's work is good, though it seems to be rather adapted for the home student than for the field-naturalist, neither family nor generic characters being included. But we observe with pleasure that specific diagnoses are given in Latin to all except the best known species, which, after the contumely that certain imperfectly educated naturalists have recently thought fit to bestow upon that classical tongue, is worthy of all praise. The references to former authors are also numerous, and, so far as we have been able to test them, more accurate than is too often, unfortunately, the case in works of this kind. But the great feature of the book are the observations on the habits and localities extracted from the note-books of the unwearied author. These are much more numerous, and better put together than in almost any other work on foreign ornithology with which we are acquainted. Errors and omissions there are no doubt, and must be, in a work of this magnitude, as indeed is sufficiently evident by the many pages of additions and corrections annexed to the fourth volume, but Herr von Heuglin has spared no trouble to bring his Ornithology of North-eastern Africa up to date, and his volumes will long remain a standard work of reference upon the birds of these districts, which are now attracting so much attention in civilised Europe.

P. L. S.

FERTILISATION OF FLOWERS BY INSECTS¹

XIII.

Additional Alpine Flowers adapted to Cross-fertilisation by Lepidoptera.

THE same relation which I have shown to exist between *Daphne Mezereum* and *striata*, *Primula officinalis* and *villosa*, *Rhinanthus crista-galli* and *alpinus* (NATURE, vol. xi. p. 110), exists also between *Viola tricolor*² and *calcarata*, the former inhabiting the plain and the lower mountainous localities, and being adapted to cross-fertilisation by bees; the latter, on the contrary, inhabiting the higher Alpine regions, and being adapted to fertilisation by butterflies.

Viola calcarata is found in the Strela pass towards Davos (2,300 metres above the sea-level), and in the rocky slopes of Piz Umbrail towards Quarta Cantoniera (2,600-2,700 m.) in such plenty as to appear from some distance like a blue carpet of flowers. In the latter locality, July 15, 1875, I saw these flowers assiduously visited by different butterflies, of which I caught two specimens of *Colias phicomone*, and three *Erebia laprona* E. (manto, W. V.). The modifications of structure by which the flowers of *V. calcarata* (Fig. 82-85) differ from those of *V. tricolor* (Fig. 15-22, NATURE, vol. ix., p. 46), besides their eminent conspicuousness, so frequently found in Alpine flowers, are such as prevent Diptera and probably also Apidæ from sucking the honey, whereas butterflies, for which alone the honey is reserved, cannot suck it without effecting cross-fertilisation. For the spur, which generally is only 3-4 mm. long in *V. tricolor*, exceeds in this species 10 mm. in length, its width being only 1 mm. in the vertical, and scarcely half a millimetre in the horizontal direction; and the stigmatic knob, provided with a labiated appendage, as in the large-flowered form of *V. tricolor*, lies so closely pressed against the under lip, that no proboscis of any butterfly can enter the spur without grazing the stigmatic lip. The pollen-grains, when they fall out of the anthers, collect in the hairs which clothe the furrow of the under lip (see Fig. 85), and no proboscis of a butterfly can be inserted into the spur without being smeared with pollen-grains, which, in the flower next

¹ "Ornithologie Nordost-Afrika's, der Nilquellen und Küsten-Gebiete, des Rothen Meeres und des nördlichen Somal-Landes," von M. Th. von Heuglin. In vier Theilen. (Cassel: Fischer, 1869-1874.)

² Continued from vol. xiii., p. 212.

³ See H. Müller, "Die Befruchtung der Blumen durch Insecten" Leipzig, 1873, p. 145, and NATURE, vol. ix. p. 44.